DTU Library

Weathering and decontamination of radioactivity deposited on concrete surfaces

Warming, Inge Elisabeth

Publication date:
1984

Document Version
Publisher's PDF, also known as Version of record

RISØ-M-2473

WEATHERING AND DECONTAMINATION OF RADIOACTIVITY DEPOSITED ON CONCRETE SURFACES

Lisbeth Warming

Abstract. Long lived fission products might be deposited in the environment after a serious reactor accident. At Risø we have studied how Danish weather conditions and fire hosing influence the decontamination of Rubidium86 (representing Cesium134 and Cesium137) deposited on concrete surfaces. Measurements have been made at two different types of concrete and at some asphalt surfaces for comparison.

INIS descriptors: ASPHALTS; CONCRETE; DECONTAMINATION; EXTERNAL IRRADIATION; FALLOUT DEPOSITS; FISSION PRODUCTS; GAMMA RADIATION; REACTOR ACCIDENTS; ROADS; RUBIDIUM 86; SURFACE CLEANING; SURFACE CONTAMINATION; URBAN AREAS; WATER; WEATHER; WEATHERING.

This work has been carried out under EEC contract no. BIO-F-423-81-F/subcontract: SC-014-F.

December 1984
Risø National Laboratory, DK-4000 Roskilde, Denmark.

ISBN 87-550-1063-7
ISBN 0418-6435

Risø REPRO 1985

CONTENTS

1. Introduction

Weathering shall here mean the reduction in dose rate from a contaminated outdoor surface caused by the influence of the outdoor conditions such as weather, traffic and normal road sweeping.

Earlier a set of experiments with fissionproducts deposited on asphalt roads have been reported (Warming 82). Many years ago Gale et al (1964) reported weathering of Cs137 in soil. Gale suggested to describe the observation matematically as:

The exposure rate

$$X(t) = X(t=o) \cdot \exp(-\lambda t) \cdot W(t)$$

where $\exp(-\lambda t)$ accounts for the decay of the radionuclide and $W(t)$ is the weathering function which should be described as a combination of exponental functions:

$$W(t) = A \cdot \exp(-\lambda_A t) + B \cdot \exp(-\lambda_B t) + \cdots$$

where $A + B + \cdots = 1$ and λ_A, λ_B, $\cdot\cdot$ are the weathering "decay"-constants corresponding to the fractions A, B, $\cdots$.

If experiments cannot be extended over many years it is most reasonable to deal only with a short- and a long term weathering. In this case A + B = 1. But it will be possible to determine only λ_A. Gale found λ_B for Cesium on soil to be about $7 \cdot 10^{-3}$ y^{-1} corresponding to a weathering half life of about 100 y.

In the experiments described here it has not been possible to determine λ_B. For accident consequence analysis it is recommended either to use Gale's value or set $\lambda_B = 0$.

2. Experiments

Two sets of experiments were made in the period 1983-84. Both sets involved four contaminated areas (see fig. 1). The first set (experiment no. 11a-d) consisted of new and old concrete surfaces with almost no traffic, and new and old asphalt surfaces with moderate traffic load. The second set (experiment no. 12a-d) consis d of two areas of new concrete, one of old concrete and one of old asphalt. With this combination of surfaces it should be possible to get a first estimate of differences in weathering of Rubidium and Cesium on concrete and asphalt.

The experimental procedure followed was basically the same as used previously (Warming 82). The contaminant was again Rb86. The initial solution has a Cs134 to Rb86 ratio of 10^{-3}. This made it possible to determine that Cesium an Rubidium have the same weathering behaviour.

The dose rate measurements consisted of a set of observations at fixed positions one meter above the road surface. For the first weeks observations were made about five times a week, later only once a week. The observed dose rates were corrected for background and decay of both Rb86 and Cs134 and then related to the dose rate of the first day of the contamination. These relative dose rates are presented in fig. 2-9.

The observation time for experiment no. 11 was only 72 days. It is seen that the short time weathering has not finish within this time, therefore the observation time for experiment no. 12 was extended even if the dose rate seriously approached background level.

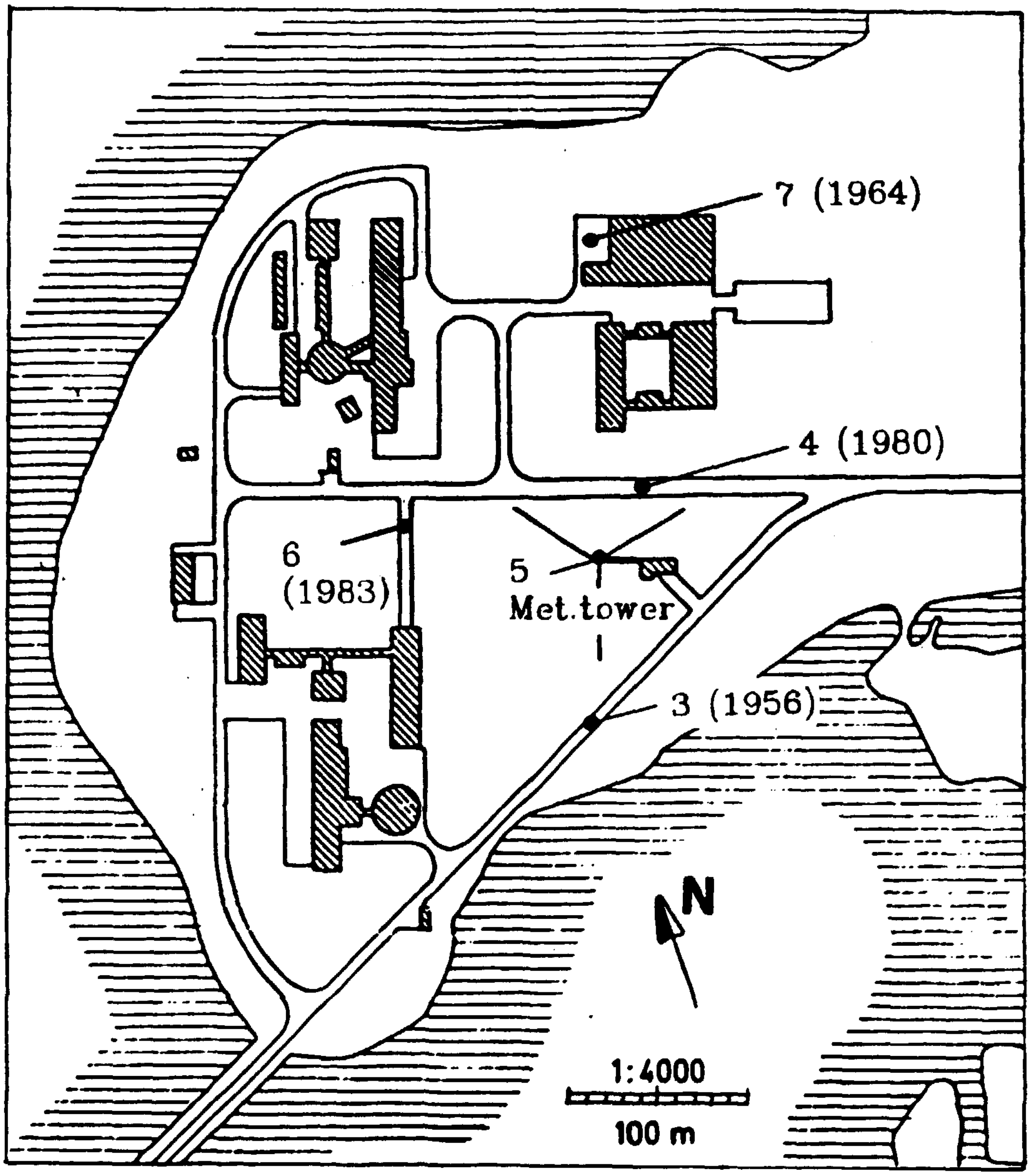


Fig. 1. Map of the Risø peninsula with the experimental areas indicated. 3 and 4 are asphalt roads (old and new, respectively), 6 is a new concrete road, 7 is an old concrete loading area and 5 is the meteorological tower from where we obtain information about precipitation.

Rainfall data was obtained from the meteorological station (5 on fig. 1). They are shown in the lower part of fig. 2-9.

The precipitation patterns in the two periods have in common that there is little or no rain for the first 30 - 40 days. Previous experiments (Warming 82) have indicated that the contamination then will be rather fixed to the surface but not so here. Except for no. 11d and 12d (very old asphalt road) all the areas show distinct reductions in dose rate when the period with rather heavy rainshowers starts.

In table 1 the dose reductions and the weathering constants observed are listed. The number of observations is too small for statistical treatment.

Exp. No.	Area No.	Surface Material	Age of Surface y	"A" Short term Weathering Fraction	Weathering Half life d	λ_A Weathering Constant d^{-1}
11a	6	Concrete	0.1	>.25	205	$3.4 \cdot 10^{-3}$
11b	7	Concrete	19	>.35	140	$5.0 \cdot 10^{-3}$
11c	4	Asphalt	3	>.60	60	$12 \cdot 10^{-3}$
11d	3	Asphalt	27	0	∞	0
12a	6	Concrete	1	.54	107	$6.5 \cdot 10^{-3}$
12b	6	Concrete	1	.60	100	$6.9 \cdot 10^{-3}$
12c	7	Concrete	20	.40	84	$8.3 \cdot 10^{-3}$
12d	3	Asphalt	28	0	∞	0

Table 1. The observed dose reductions and short term weathering half lifes. The area numbers correspond to those given on fig. 1.

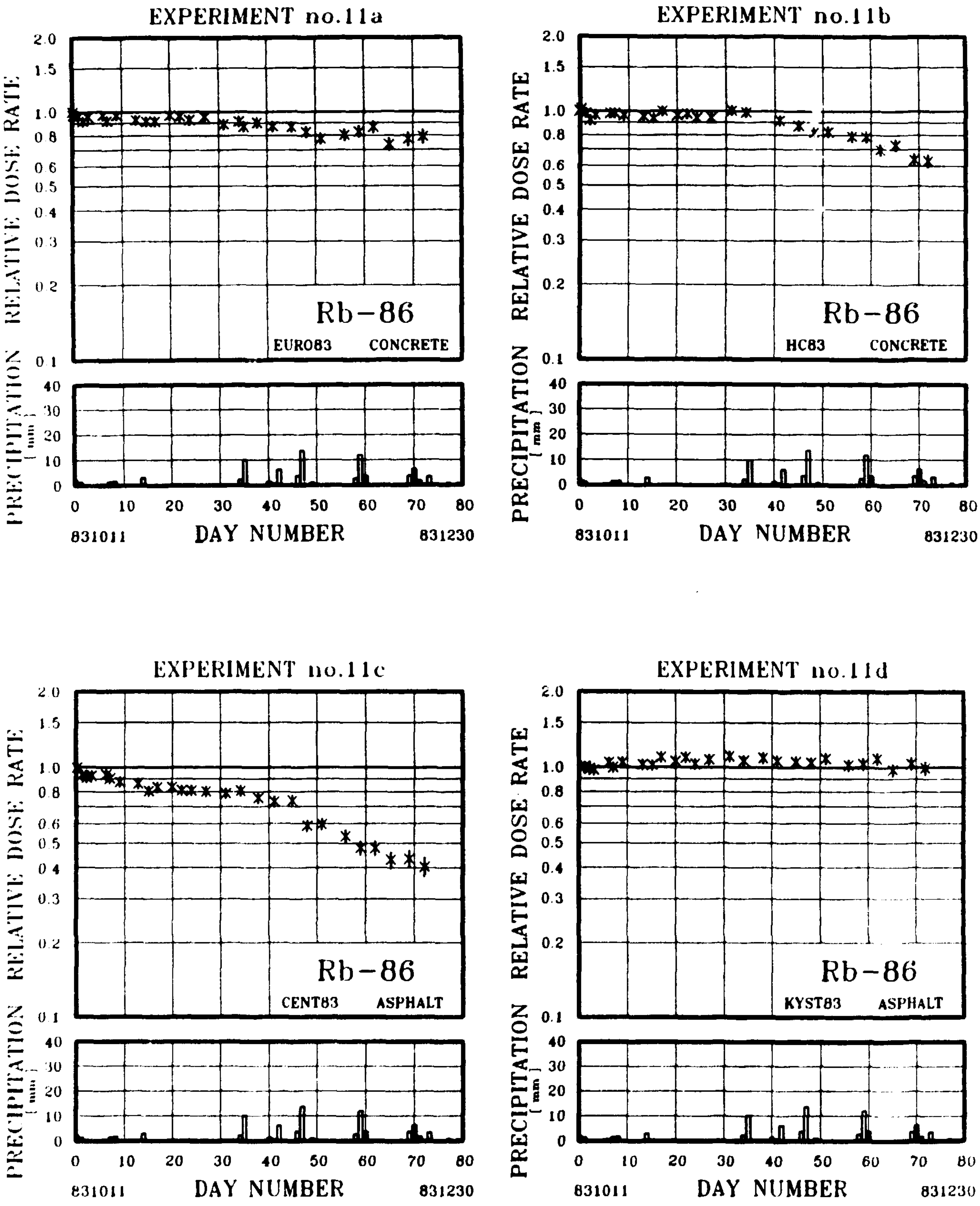


Fig. 2-5. The change in the relative dose rate due to weathering W(t), as obtained in the first set of experiments (october to december 1983). Each figure shows the data for one area together with the rainfall in the observation period.

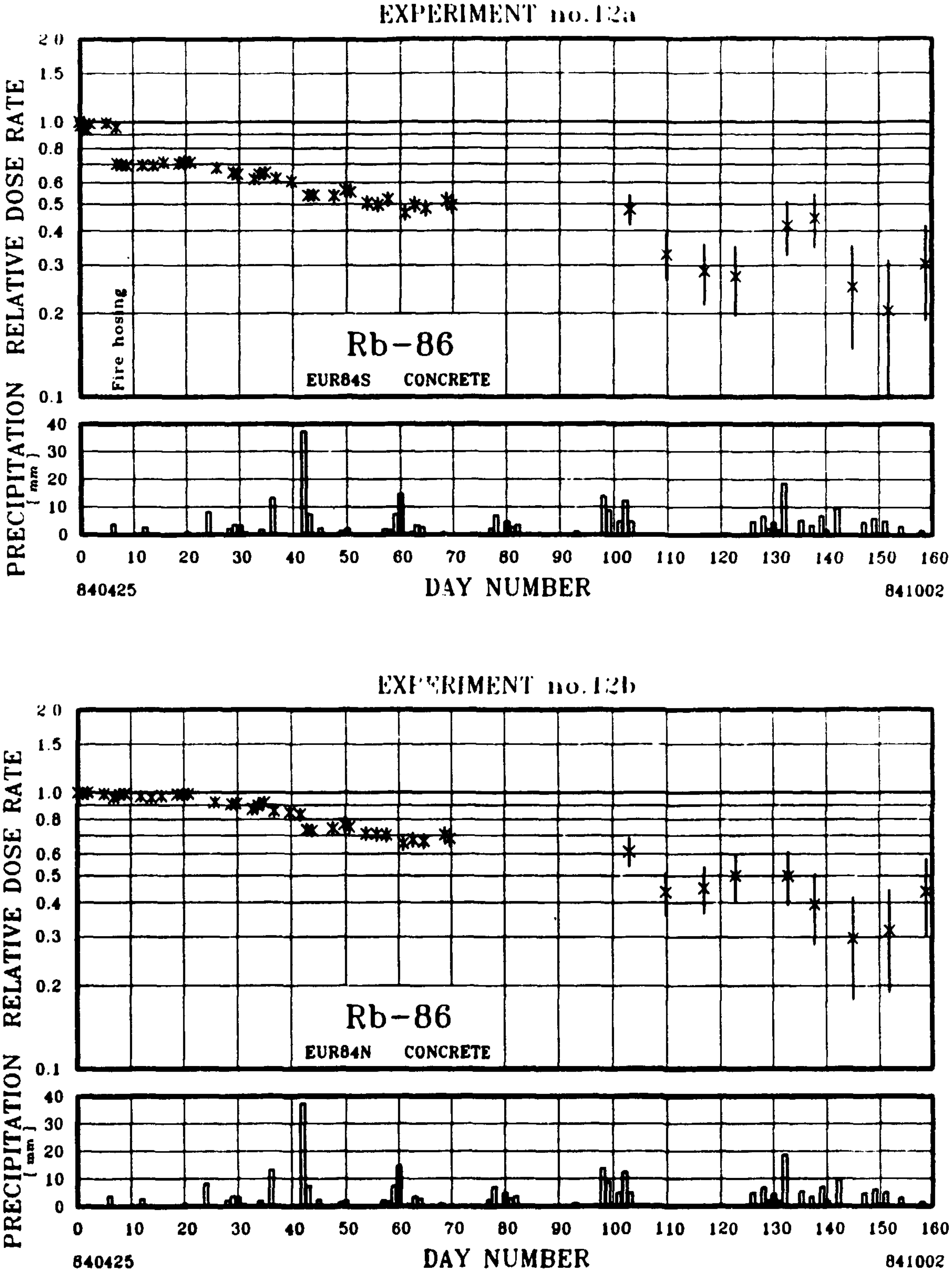
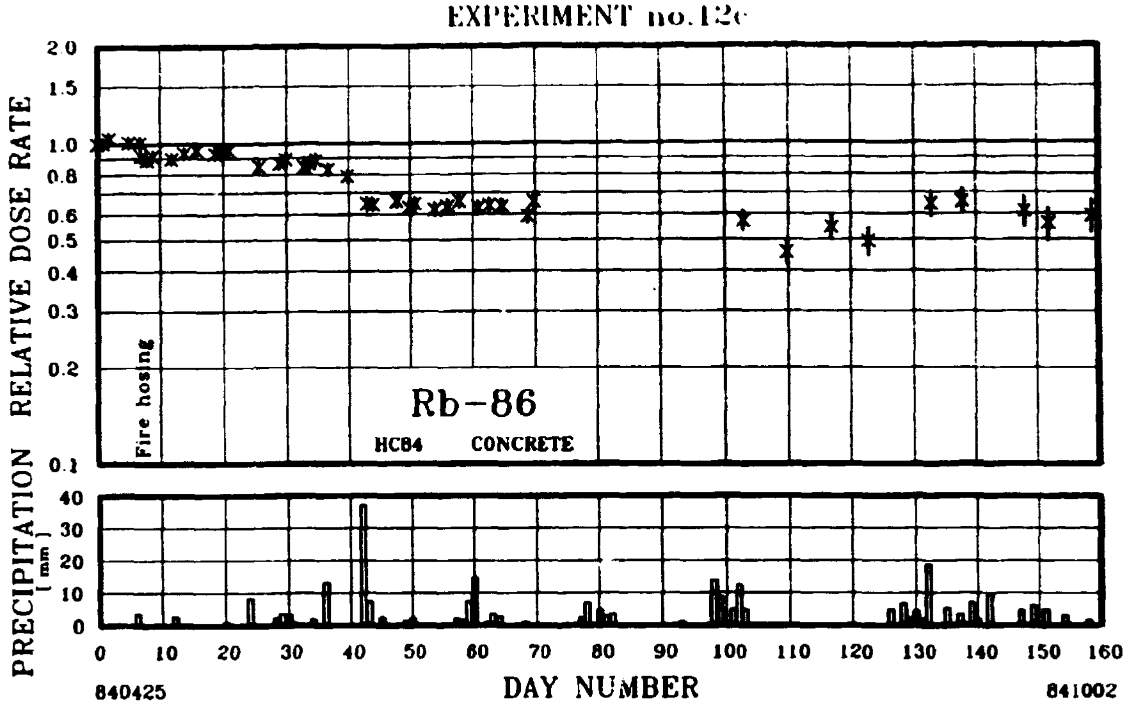


Fig. 6-7. The change in the relative dose rate due to weathering, W(t), as obtained in the second set of experiments (april to october 1984). Each figure shows the data for one area together with the precipitation in the period. In experiment 12a the area was firehosed on the seventh day.



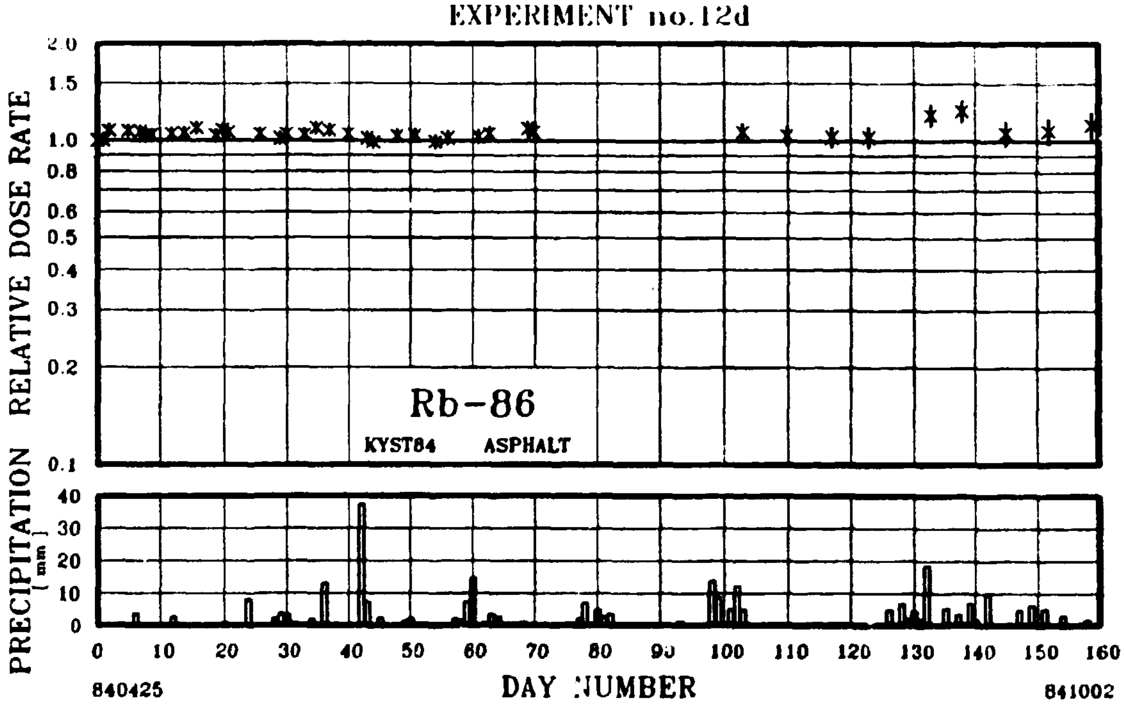


Fig. 8-9. The change in the relative dose rate due to weathering, W(t), as obtained in the second set of experiments (april to october 1984). Each figure shows the data for one area together with the precipitation in the period. In experiment 12c the area was firehosed on the seventh day.

3. Decontamination

Table 2 gives the dose reductions found in the decontamination attempts of fire hosing the two concrete areas. The reductions obtained cannot be said to be encouraging but they do not really differ from the results on asphalt (Warming 82).

Exp. no.	Area no.	Age of Contamination	Decontamination Factor
12a	6	7d	1.3
12c	7	7d	1.1

Table 2. Results of Forced Decontamination by Firehosing.

Comparing 12a and 12b it is interesting to see that the A-factors and the weathering constants are very much alike. This indicates that the fire hosing of 12a has had no influence on the following weathering.

4. Conclusions

As in the previous series of experiments (Warming 82) there are large variations in the results, and because there are only 5 experiments on concrete and 3 on asphalt we have to be cautious about drawing conclusions.

There is a certain indication that young concrete surfaces like young asphalt surfaces are more "contamination repellant" than old ones. For 1 year old concrete a maximum of 60% of the contamination is weathered away with a half life of 100 days. For young asphalt 60% is removed with a half life of 60 days.

The old concrete surface (11b and 12c) showed a larger A-factor (≈ 0.4, half life about 100 days) than the corresponding old asphalt surface (11d and 12d). The latter shows absolutely no signs of weathering.

Forced decontamination of concrete surfaces by firehosing has not been very succesful (less than 25% dose reduction). The firehosing, though, does not affect the subsequent weathering. This might mean that water on a concrete surface does not help chemical reactions between the surface and Rubidium and Cesium as does water for asphalt.

5. References

Gale, H.T., D.L.O. Humpreys and E.M.R. Fisher: Weathering of Cesium-137 in Soil. Nature 201 (1964) 257.

Warming, L.:
Weathering and Decontamination of Radioactivity Deposited on Asphalt Surfaces. RISØ-M-2273. 1982.

Risø - M - 2473

Title and author(s)	Date
Weathering and Decontamination of Radioactivity Deposited on Concrete Surfaces Lisbeth Warming	December 1984
	Department or group Health Physics
	Group's own registration number(s)
13 pages + tables + illustrations	
Abstract	Copies to

Long lived fission products might be deposited in the environment after a serious reactor accident. At Risø we have studied how Danish weather conditions and fire hosing influence the decontamination of Rubidium86 (representing Cesium134 and 137) deposited on concrete surfaces.

Measurement have been made at two different types of concrete and some asphalt surfaces for comparison

Available on request from Risø Library, Risø National Laboratory (Risø Bibliotek), Forsøgsanlæg Risø), DK-4000 Roskilde, Denmark
Telephone: (03) 37 12 12, ext. 2262. Telex: 43116